Ministry of Agriculture and Food

Ontario

ORDER NO. 90-220
OCTOBER 1990
AGDEX 290
57

Factsheet

POST-HARVEST HANDLING OF GREENHOUSE VEGETABLES:
STRATEGIES FOR THE PREVENTION OF ETHYLENE DAMAGE

A.P. Papadopoulos, Agriculture Canada, Research Station, Harrow
S. Khosla, Plant Products Co. Ltd., 314 Orenda Rd., Brampton

91-02486/

The Canadian greenhouse vegetable industry has the potential of meeting the domestic demand for high quality salad vegetables. With modern greenhouses and soilless media, growing conditions can be controlled to allow production of high quality produce in abundance. However, improper crop management and poor postharvest handling and storage practices can result in low quality greenhouse produce that may find its way to the marketplace. Low quality produce has frequently been associated with the presence of high atmospheric concentrations of ethylene gas.

What is Ethylene Ethylene (C_2H_2) is a colorless gas, a well known plant hormone, produced in varying quantities by most plants. It induces senescence of the leaves and promotes ripening of fruits thus decreasing storability and shelf-life. The level of ethylene that affects plants can be as low as 0.01 ppm and depends upon the plant species, the particular plant organ, and the age.

Ethylene released by produce can accumulate in poorly ventilated storage facilities causing injury to the stored produce and decreasing quality and shelf-life. Alternatively, the gas may initially be absorbed by the insulation materials and released back into the storage atmosphere at a later time causing the same problems. At room temperature, ethylene will rapidly affect plant material, but, under cold storage conditions (3-4°C) its effects are slower.

Sources of Ethylene The combustion of fossil fuels for heating and the powering of engines is a common source of ethylene. Motorized vehicles such as trucks and lift forks, refrigeration units, power generators etc. are potential ethylene producers. Field tests conducted across a number of packing houses in Leamington, Ontario, revealed ethylene concentrations in the storage rooms ranging from 0.25 ppm to 2.00 ppm (average of 1.1 ppm). These levels are potentially harmful to the stored produce. Ethylene levels recorded in the packing areas were lower, possibly due to better ventilation. However, measurements taken in the receiving areas in the presence of motorized machinery registered ethylene levels similar to those found in the storage rooms. Therefore, the two areas in the packing houses where ethylene concentrations may be a problem are the receiving area and the actual storage rooms.

Stored fruits and vegetables themselves are an important source of ethylene found in storage facilities. Ethylene produced from the fruit during ripening varies depending upon the kind of fruit, the degree of ripening, as well as the storage temperature. Tomato and cucumber fruit produce moderate to high levels of ethylene when ripening.

The tomato fruit, in particular, has a climacteric ripening process in that high respiration rate at ripening is followed by a low respiration rate and an accelerated production of ethylene. Studies have shown that ripe tomato fruit produced 600 times more ethylene than unripe fruit.

The ethylene that is released from stored fruit causes faster ripening of adjacent fruit. Some ethylene sensitive fruits and vegetables when stored together in the same facility with heavy ethylene producers undergo faster ripening and/or exhibit ethylene injury.

Most greenhouse vegetables are sensitive to ethylene. Exposure to low levels of ethylene (0.1-1ppm) can result in faster ripening and result in abnormal coloration of the tomato fruit, accelerated softening and yellowing of the cucumber fruit, and russet spotting of lettuce.

Studies conducted in Holland have shown that 3 ppm of ethylene caused yellowing in cucumbers within five days from harvest and that levels as low as 0.3 ppm were adequate to promote accelerated ripening. Packing tomato and cucumber fruits together in a plastic bag resulted in ethylene levels of 15-20 ppm and caused complete yellowing of the cucumber fruit within one week. Storing cucumbers alone under the same conditions did not result in any injury symptoms. Therefore, storing and shipping tomatoes and cucumbers together is not advisable.

Ethylene production from the fruit, as from other plant components, is related to the storage temperature (higher rates at warmer temperatures) and stage of maturity. Proper post-harvest handling of the product is necessary to minimize ethylene production and to maintain good shelf-life.

Studies in England have shown that a storage period at a low temperature (2°C) followed by a storage period at room

temperature resulted in increased disease incidence on the tomato fruit. The length of the low temperature storage period determined the severity of the disease. Increased microbial activity generated more ethylene as well as destroyed fruit quality and increased ethylene release from the infected fruit.

In Canada a study has shown the importance of fruit handling. Tomato fruits that were dropped from various heights produce more ethylene than the non-bruised tomatoes. The increased ethylene production by the damaged cells causes faster ripening and a shorter shelf-life. Decaying plant material is also a source of ethylene. Clean receiving, packing and storage facilities are necessary and decaying and diseased produce should be moved off-site immediately.

Storage and Handling The **optimum cold storage conditions** for some of the most common greenhouse vegetables are listed in Table 1. Although lower temperatures from those listed may be used to slow down ripening, chilling injury may result. Removal of ethylene from the storage facility or decreasing ethylene production by the fruit are the two common methods used to extend shelf-life and maintain fruit quality.

Controlled atmosphere storage (CAS), where the atmosphere in the storage room was modified to 5% O_2, 5% CO_2 and 90% N at 12.5°C, increased storage life of tomatoes to 10 weeks without apparent deleterious effect on fruit quality. Ethylene levels in the CAS facilities are generally lower due to the use of scrubbers and also because the modified atmosphere in itself results in low ethylene production. Complete removal of ethylene from the storage facilities is not recommended since ethylene is required for normal ripening to occur. Controlled atmosphere storage may have a place in the greenhouse industry. At certain times of the year, when the supply is large, portions of the harvest may be placed in small, efficient controlled atmosphere rooms and then released when the produce supply at the market place is low. The storage period should not exceed 8-10 weeks; otherwise, there would be a loss in quality.

Modification of the atmosphere within a pack may be an alternative way of increasing shelf-life. Packaging the fruit in a suitably permeable film to equilibrate at 4-6% O_2, and 4-6% CO_2 within the package should slow down ripening and increase shelf-life by 10-14 days at room temperature.

Low pressure storage may also increase product storability. Tissue ethylene level is decreased in these facilities because the lower air pressure causes a more rapid loss of ethylene from the tissues into the air. Also, the continued extraction of the atmosphere from the storage facility decrease ethylene accumulation.

Post-harvest treatment of produce to reduce the rate of ripening and ethylene production is another way of maintaining shelf-life and quality. Removal or elimination of microbes on the surface in combination with cold storage will reduce disease incidence and improve shelf-life. Coating produce by dipping or spraying with a non-toxic chemical capable of preventing fungal growth would also help.

Future Prospects Special food grade waxes and more recently biodegradable polymers have shown good results when tested with apples. Such products, when applied as a thin coating on apples prevented fungal growth from occurring. Tests conducted on tomatoes and peppers have also shown promise. Future developments in applying coatings to the fruit to delay loss of fruit quality may be of benefit to the greenhouse industry.

Fruit quality at the market place is necessary to maintain an edge over the competition. Quality can not be added but only be preserved once the product is harvested.

Table 1. Recommended storage conditions for greenhouse vegetables.

	Temperature (°C)	Relative Humidity	Storage Life
Cucumbers	10-13	90-95	10-14
Lettuce, head	0	95	2-3 weeks
Lettuce, leaf	0	95	3-6 days
Peppers	10-12	90-95	1-2 weeks
Tomatoes, green	12-13	85-90	2-3 weeks
Tomatoes, ripe	2-5	90	3-5 days

6M
ISSN 0225-7882